It acquires these properties again directly small quantities of electrolytes are present, and it is argued, therefore, that the physical properties of gluten are largely controlled by the presence of salts. The analytical study of strong and weak flours, made by Prof. Wood, in following this clue, indicated that the former contained a larger proportion of phosphates: this gave the stimulus to Mr. A. E. Humphries—a practical miller—to try the addition of an extract of phosphates from bran to a weak flour, and when this addition proved advantageous in increasing the strength, the effect of adding small quantities of pure phosphoric acid was tried in its turn. A great deal of painstaking research has been necessary for the elaboration of the new technique of improving flour, and it is now commercially possible to impart the qualities of strength to a weak flour, so that it works better in the dough, has an increased water absorption, and gives a larger loaf of lighter texture, which is more easily digested than when untreated. One result of the treatment, which is of the highest national importance, is that it enables a larger proportion of English wheat to be used in the bread mixture. Notwithstanding all that is said by food reformers and agitators in the daily Press, the public do demand a certain degree of lightness and texture in their daily bread, for which the presence of a considerable proportion of strong foreign wheat in the mixture is essential. This is especially the case in the large manufacturing towns in the North: any sceptic as to the difference can easily make the experiment of comparing the bread from two kinds of flour at his own table.

English wheats as a class yield weak flours, characterised by their excellent flavour. Since they can only be used by the baker to a limited extent they fetch a correspondingly lower price on the market, and to-day are very largely used for household purposes where strength does not matter. The possibility of using a considerably increased percentage of home-grown wheat in the bread mixture is bound to have a favourable effect on the price, the more so as the small country miller can make use of the local supplies near at hand and will be much less dependent on the supplies of foreign wheat, on which he has to pay freight from the ports of entry where the large milling concerns, with which he is in competition, are usually situated. Chemical science has thus rendered a service which promises to be of the utmost importance to the farmer and the country miller.

It is, of course, necessary that a close control should be exercised over the materials allowed to be used as improvers, and nothing but the spraying with soluble electrolytes in minute quantities should be allowed, anything in the nature of loading the flour being strictly prohibited. There is still much prejudice to be overcome against any scientific treatment of wheat, although the baker is allowed free latitude to make the best possible looking loaf from the flour available—an obviously irrational position.

Returning to the scientific aspect of the difference between strong and weak flours, it would appear to be yet another instance of those elusive problems in the chemistry of organic colloids such as are concerned in most physiological problems and most of all in that of life itself. The state of aggregation of the colloid and its susceptibility to this and that alteration, owing to the presence of electrolytes of acidic or basic character, as manifested by changes in the physical properties is a general problem which is engaging the attention of many workers. In the case of flour, sufficient has been done to enable great advances to be made on the purely utilitarian side, though their theoretical explanation may be still veiled in obscurity.

Although strength in flour has been traced as due to the state of the colloid protein brought about by the presence of a certain proportion of electrolytes, our knowledge is still too indefinite to enable the farmer to produce a strong wheat by appropriate manurial treatment. The Cambridge School of Plant Breeders has offered good evidence that strength is a factor in the Mendelian sense, and it is considered possible by appropriate selection to obtain a wheat suitable for English soils which will combine strength with the equally important factors of yield and good straw. The efforts of the Home-grown Wheat Committee to encourage the growth of strong wheats in this country have met with only partial success, because, as a rule, strong wheats give poor yields and inferior straw. Much further research is necessary, which can only be done effectively at agricultural stations, such as Rothamsted, or by the agricultural departments of the universities. The composition of the flour is due to the state of maturation of the wheat berry at the time of harvesting, and it will be valuable to know the strength of the wheats produced on the individual plots at Rothamsted with different manurial treatment.

However, as shown above, the short cut which the miller is able to take renders him much more independent of the nature of his wheat supply, and it is probable in consequence that the considerable difference in price between strong and weak wheats will disappear to a large extent in the near future, so that the incentive to the farmer to grow strong wheats in this country will disappear. That they can be grown has been proved.

E. F. ARMSTRONG.

THE FOOD OF BRITISH WILD BIRDS.

SCIENTIFIC investigations concerning the economic importance of our British wild birds are of comparatively recent date, so that at present the sum total of our knowledge is only limited. To arrive at the precise economic value of each of our commoner species is a task of no mean magnitude, and yet it is slowly but surely being forced upon the minds of all thinking people who are concerned with the produce of the land

and of our fisheries, that such work is more and more becoming a necessity and one also fraught with great possibilities. So clearly has this been recognised by other countries that special State officers devote the whole of their time to the elucidation of the various problems in connection with economic ornithology. If a particular species confers greater benefits than injuries, and we are not affording it all the protection possible, we are pursuing a downgrade and very dangerous course, which cannot fail but produce direct injury to the State.

The subject is a complex one, approachable from many sides, and any investigations, to be of real value, must entail a large amount of careful and detailed work extending over some considerable period of time. The mere cataloguing of the crop or stomach contents of a limited number of specimens of any species, obtained at a particular period from one locality is really of very little value. As the writer has elsewhere stated,[1] "In order to arrive at a proper understanding of the food of any particular species, it is necessary to examine the food contents found in the intestinal tract during the different seasons of the year and from various districts. Further, careful observations must be made in the field, and of the nature of the food brought to the nest by the parents during the breeding season, and also of the fæcal contents extruded from the nest."

We now know that many of the earlier records are either only partially correct or will scarcely bear the interpretation put upon them by their respective authors, for two most important factors have been overlooked, viz., the rate of digestion, and the intestinal food contents found beyond the region of the gizzard. The rate of digestion, according to experiments at present in hand, would seem to vary in different groups of birds; as yet but little work has been done in this interesting field, a more accurate knowledge of which must largely alter our ideas of the various statistical tables which have been given for different species.

Under certain conditions, *e.g.*, during dry summers,[2] a much larger percentage of weed seeds pass through the intestinal canal uninjured, due to the fact that under such climatic conditions a much smaller percentage of grit and soil is taken into the intestinal canal. Thus, observations made upon the grit and soil content in the gizzard of thirty-six rooks during the dry summer of 1911 (June to September) showed that the average content was 108 grains, of which not more than one-sixth was grit, whereas in the same number of birds examined during the wet summer of 1912, the average amount was 214 grains, of which nearly one-third was grit. Similar investigations carried out on the starling and house-sparrow gave an average, in 1911, of 42 and 27½ grains respectively, as against 68 and 53 grains in 1912.

In the past it has been all too readily assumed that those species that feed upon insects and upon weed seeds must be beneficial. We now know that no hard and fast line can be drawn: much careful and extended work is necessary on each individual species before it can be definitely stated that a species is injurious or beneficial.

To the farmer and fruit grower such information is of the greatest import, for at the present moment they suffer enormous annual losses due to certain species of birds.

Of the majority of species of British wild birds, it is generally agreed that they are beneficial, of the remainder the present writer has elsewhere stated that: "Many species which are injurious at one season of the year are distinctly beneficial for the remainder. Again, many birds that are beneficial, may, if allowed unduly to increase, become equally injurious. In other cases the partial failure of their natural food supply, or other causes, may lead to a change in their food habits, in a like manner, the alteration or removal of their natural environment may lead to equally disastrous results."

Although in some districts farmers and others are loud in their complaints of the injuries inflicted, any policy of wholesale destruction would, we believe, be equally disastrous. In nearly all cases, "the misdeeds of birds are much more manifest than the benefits they confer upon us."

With the exception of doves and pigeons, practically all birds feed their young upon an animal diet, whatever the nature of the food of the adult may be, and the bulk of the food consists of insects. These are destroyed just when they are capable of inflicting the greatest possible harm upon our crops and orchards. Further, during the nestling season, the young birds require an enormous amount of food; feeding commences before sunrise and continues after sunset. The starling is known to pay nearly 200 visits to the nest a day, and in the case of the house-sparrow, between 220 and 260 visits daily have been counted. In any attempt, therefore, to estimate the value or economic status of a species, the nature of the food of the nestlings must be taken into consideration.

A careful investigation extending over a period of ten years, entailing an examination of the stomach contents of upwards of 4000 adult birds and 600 nestlings, and numerous observations in the field and laboratory shows that we can classify the commoner species under five headings, viz.:—

1. *Distinctly injurious.*—House-sparrow, bullfinch, sparrow-hawk, wood-pigeon, and stock-dove.
2. *Too plentiful, and consequently injurious.*—Missel thrush, blackbird, greenfinch, chaffinch, starling, and rook.
3. *Injurious, but not plentiful.*—Blackcap.
4. *Neutral.*—Jay.
5. *Beneficial.*—Song thrush, fieldfare, whitethroat, great tit, blue tit, wren, goldfinch, linnet, yellow bunting, magpie, jackdaw, skylark, barn owl, brown owl, kestrel, and plover.

The so-called "avian rat," the ubiquitous house sparrow, has probably received more attention from naturalists than any other wild bird, but in spite of all the deprecatory language that has been applied to it, this bird has its redeeming features. It has been allowed to increase to such an extent that it has become one of the worst bird pests we have.

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[1] "The Food of Some British Wild Birds," 1913, p. 7.

[2] *Journ. Econ. Biology*, 1914, vol. ix., p. 69.

In the writer's investigations upon this species, commenced in the early part of 1910 and completed in May, 1914, 404 adult birds were examined and 329 nestlings. Of the former, 207 were shot in or near orchards, 138 in agricultural districts, and 59 in suburban districts. The stomach contents of the birds from the fruit-growing districts showed that the bulk of the food consisted of the caterpillars of injurious insects and weed seeds; in only twenty-three cases were the remains of blossom buds discovered, and in twenty-seven cases wheat grains. There is only one conclusion that we can come to as regards this record, viz., that this much maligned bird is distinctly beneficial in such districts. Unfortunately when we examine the record of 138 specimens from agricultural districts, we find a very different result. Remains of insects occurred on only twelve occasions, whereas wheat grains were found on 115, and the remains of other grains 43 times. The 59 specimens from suburban districts showed a very mixed diet. The stomach contents of the 329 nestlings consisted almost entirely of insect remains.[3]

From the above somewhat exhaustive record it would seem clear that in all agricultural districts sparrows should be given no quarter, whilst in fruit-growing districts and towns they are far too plentiful.

Undoubtedly the worst bird pest the farmer has to contend with is the wood pigeon. Gilmour[4] examined the stomach contents of 265 birds, and stated of the results: "There is no uncertainty, no dubiety about the meaning here: the figures, as given by himself, condemn, and we cannot but convict." The writer examined 388 birds and concluded that there were no extenuating circumstances that would lead him to alter an opinion formed many years back, that no quarter should be shown to it, and that every means should be taken to destroy it.

It frequently happens that when a particular species of bird becomes too plentiful, it changes its food habits, and this, to a large extent, is what has happened in the case of the birds scheduled under this heading. The missel thrush and blackbird have increased enormously in recent years and both have become serious pests to fruit-growers. The damage occasioned by the greenfinch and chaffinch is chiefly to newly sown seed and sprouting corn; both species are too numerous. Each year we hear more and more of the damage done by the starling and the rook. During the past ten or twelve years the former species has greatly increased; such increase being largely due to migration and to the protection afforded wild birds generally. At present it commits a large amount of damage, but if it were considerably reduced in numbers, it would prove, as in the past, a most useful bird.

Numerous investigations on the food of the rook have been carried out, and all have shown that the species is too numerous and consequently injurious. Gilmour[5] examined the stomach contents of 355 birds, Florence[6] 162, Thring[7] 141, and the writer[8] 689.

One regrets to have to condemn such a pretty little summer visitant as the blackcap, but careful observations, extending over eight or nine years, proves that it commits grave havoc in the orchard, and further, it has considerably increased in numbers during this period. Owing to the persecution of the gamekeeper, the jay is, in many districts, annually becoming rarer. Where it is at all plentiful, it undoubtedly steals the pheasant food and the eggs of game birds; it also bites pieces out of rosy-cheeked apples and strips the pods of peas, but it destroys blackbirds and mice, and consumes large quantities of injurious insects and slugs.

In connection with all the species mentioned as beneficial, we should like to see more stringent laws for their protection. It is ridiculous fining the schoolboy for taking a few eggs and allowing the dealer and bird catcher to defy the law.

There is no longer any doubt as to the great value of the barn owl and the brown or tawny owl to the agriculturist, and yet they are destroyed wholesale by gamekeepers and others. Or take the case of the plover. It would be difficult to exaggerate the value of this bird to the farmer. The good it does cannot be over-estimated, and yet the farmers of this country are annually watching its gradual reduction with indifference.

Many species of birds, that otherwise are beneficial, are active agents in the dispersal of weed seeds. In some species the seeds are ground up in their muscular gizzards, but in others this action is so slight that many of the seeds pass through the body uninjured. Thus, such birds as the blackbird, thrush, house sparrow, bullfinch, and greenfinch are now known to be great distributors of weed seeds, and such must be taken into consideration in any attempt rightly to fix their economic status.

Space forbids any reference to such matters as the status of game and sea birds, or the subject of legislation and other means of protecting wild birds, but enough has been said to show how wide is the range of investigation in this important subject. Unfortunately, none of our universities have chairs or departments of economic ornithology, nor is there any adequate aid being offered to the investigator by the State. In common with most scientific investigations, those concerning economic ornithology entail considerable time and expense, frequently beyond the means of the private individual, to whom the work has, thus far, been very largely left. With some State recognition very important results would accrue which would prove of value to agriculture and the fisheries.

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[3] *Journ. Board Agric.*, 1914, vol. xxi., pp. 618–23

[4] Trans. Highland and Agricultural Soc. Scotland, 1896, pp. 21–112.

[5] *Op. cit.*

[6] Trans. Highland and Agricultural. Soc. Scotland, 1912, pp. 180–219.

[7] *Journ. Econ. Biol.*, 1910, vol. v., pp. 49–67.

[8] *Ibid.*

WALTER E. COLLINGE.

ATTEMPTS TO MANUFACTURE SCIENTIFIC DISCOVERY.

IN an excellent article forming one of his admirable series of essays entitled "Science from an Easy-chair," published in the *Daily Telegraph* of December 15, 1914, Sir Ray Lankester deals particularly with the case of the recent proposal that the Lister Institute should be handed over to the Medical Research Committee of the National Insurance Commission. The proposal was rejected on November 18 by the votes of the members; and Sir Ray Lankester preaches a useful sermon upon this text. He maintains that men of science "have no confidence in vague invocations of 'centralisation' and 'co-ordination'—abstractions with which Lord Moulton endeavoured to allure them. They do not wish to see the Institute placed at the disposal of centralisers and co-ordinators. The men they desire to maintain in undisturbed control of the Lister Institute are of a totally different class, namely, the rare individuals known as 'scientific discoverers'—a variety of humanity impossible to drive or to co-ordinate, inevitably paralysed by official programmes and stultified by ignorant though well-meaning superintendance." He continues:—

> There is a widespread but erroneous belief in official circles, and among wealthy philanthropists, to the effect that you can hire a scientific discoverer and then say to him, "Discover me this" or "Discover me that" (naming to him a possible and greatly desired piece of new knowledge), and that he will thereupon proceed right away to make the discovery which you want. . . . But valuable and important scientific discovery cannot be produced directly in response to orders given and money expended. You cannot manufacture scientific discovery like soap. The great difficulty, in the first place, is to catch that rare and evasive creature—a scientific discoverer—and when you have found him you have to humour him and let him do as he fancies. Then he will discover things, but probably not the things which either you or he wanted or expected.

All this is very true, and I for one entirely agree. But I think that we should distinguish between *major discovery* and *minor research*. To be frank, the former has been made almost entirely by amateurs, or at least by men who were amateurs when they started; and such discoveries are somewhat rare and depend upon the production by nature of a peculiar and equally rare type of mind. Thus history shows that there are vast nations, consisting of hundreds of millions of people, who never make a scientific discovery from century to century; while, on the other hand, small peoples who appear to be in some favourable biological condition, turn out major discoveries by the score. To me it has always seemed that major discovery is a kind of efflorescence of the human race, occurring only for a brief period in the life of a people. But minor discovery, or rather research, is of another order. It is not of the epoch-making type of major discovery, but is still useful and must not be depreciated. In the present day, when science has advanced so much, this second class of research becomes absolutely necessary for the purpose of filling in the innumerable petty details which go to complete a great scientific theorem; and the difference of opinion which certainly exists regarding the best method of encouraging discovery depends chiefly upon a failure to make this distinction. Thus, when some of us talk of research, they refer only to major discovery, while others refer only to the minor work.

My own opinion is that both should be clearly recognised. The best way to encourage major discoveries is to remove difficulties as much as possible from the path of the unique individuals who make them; and that is why I have always advocated a proper State recognition of such work. On the other hand, minor researches do require a certain amount of organisation—though, even here, great care must be taken not to interfere by too much direction from above; and the question is what kind of organisation is the best. At any rate, most men of science will agree with Sir Ray Lankester when he records a note of objection to "the existence of a Board of Trustees with a Managing Committee, or of any committee playing the part of employers and proprietors towards the men of science who are heads of laboratories in an institution designed for scientific discovery."

Personally, I think that our British notion of constructing such committees chiefly out of "superannuated politicians, retired civil servants, lawyers, medical men, peers, and clerical dignitaries, as well as men who have made fortunes and retired from business," is quite foolish, and indeed improper. But we seem to pursue this habit in nearly everything—the argument being apparently that the men who know nothing about a subject are the best to direct efforts in connection with that subject; so that we appoint lawyers to be heads not only of scientific and learned institutions, but even of the War Office and the Exchequer. In my own humble opinion, lawyers would be much better employed in revising or reforming the mass of confusion (as they themselves admit it is) called law. I do not object to lawyers more than to other amateurs being placed in such positions; but the point is whether research institutions should not be put exclusively under the management of men who have proved their capacity for research by success in it—and only under such. The existing British custom has an unpleasant savour of secret wire-pulling and other methods of acquiring "influence." It would be quite useful, were it possible, to analyse the committees of our few research institutions; but the time has come when men of science should begin to look into all these matters a little more closely than they have done in the past.

RONALD ROSS.